Indian Journal of History of Science, 41.1 (2006) 77-96

SOME MEDIEVAL MANUSCRIPTS ON HORTICULTURE

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(Received 12 July 2004)

Medieval India had large number of orchards, but possesses a few manuscripts on horticulture. Manuscripts are mostly anonymous and undated fragments. Their fragmentary nature is due to the fact that these are compilations of information from some earlier source(s). Three primary sources for such compilations are examined. In the ultimate analysis these three boil down to just one. This primary source is titled *Ganj Badaward* of Amanullah Khan alias Khanzaman Firuzjang who was a court physician to the Mughal Emperors Jahangir and Shahjahan. The original source is primarily a treatise on *Unani* medicine wherein other related aspects are added to make it comprehensive. While others have copied details of grafting knowledge in general from the *Ganj* without adding any significant detail of their own, the *Risala Nakhlbandiya* refers to the grafting techniques used in case of mango. This method was of course commonly employed in Murshidabad of Bengal. While central Asian horticultural sources discuss problems of honeybee culture, the Indian horticultural sources are silent on this count. On the other hand Indian horticultural sources discuss silkworm. An unpublished manuscript source of *Unani* medicine however provides substantial details regarding both honeybee and silkworm breeding.

Key words: Horticultural techniques, Medieval Indian Horticulture, Medieval Indian Science and Technology.

INTRODUCTION

In available literature horticulture is treated as a subsection of agriculture. On this ground Lallanji Gopal has opined that revenue documents, histories, memoirs etc. are important sources to overcome this paucity of information[1]. This understanding of medieval horticulture entirely ignores the fact that orchards played an important role in medieval society and this role was independent of agriculture *per se.*

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During the medieval times we first meet a significant role of orchards even when the Turko-Afghans were yet trying to fully establish their rule in Delhi. Meo-attacks on Mehrauli are well known. Ghayasuddin Khilji discovered their huge hideout on the Delhi Ridge. In a fierce battle at Talkatora he defeated them. From this moment as a matter of policy the jungles were removed from the environs of Delhi i.e. up to 60-kos radius from Mehrauli. The land thus made available was assigned to various categories of people and institutions that overwhelmingly established orchards on this land [2]. Such change in land-use pattern has been an old tradition in India; Kauṭilya has dealt with this aspect in detail [3]. Physical location of these orchards on the Ridge also obliged the assignees to keep an eye open for security considerations. Hence, a chain of various institutions located on the Ridge and around, the remains of which can yet be seen.

Arab travelers were of the opinion that due to their large numbers these orchards provided cheap fruits and vegetables to Delhi [4]. Orchards were also used as temporary residential grounds for either enjoying nature or escaping heat and epidemics. Barni mentions that there were more than two thousand orchards in the environs of Delhi amongst which the imperial orchard was five *kos* long and one *kos* wide. It was here that Alauddin Khilji latter settled and built his capital after his defeat in the war with the Mongols. He considered this piece of land as very auspicious [5].We also notice a number of orchards emerging in Hisar-Firuza during the reign of Firuzshah Tughlaq when the canal brought water to this area that was earlier a waterless and barren *Talwandi* dominated by thorny bushes and trees [6].

Under the Mughals orchards were every where. Those attached to the mausoleums were open to public for recreation, except for a few days that were reserved for the Royal to pay homage to their forefathers. The product of these orchards was by definition not meant for the market. Hence, these were not taxed and the product was not entered in the revenue documents. The rare plants and fruits were part of the traditional list of royal presents as enumerated. For example, there are recorded instances by Sir Thomas Roe that the king presented plants, to the nobles who had to be grown under proper attention and to be periodically reported to him on their progress[7]. Presenting new varieties of fruit developed in personal orchards to the king and getting his admiration is

also well recorded. These instances more clearly show that medieval orchards performed an important and varied social function. Hence, to treat orchards as a minor adjunct of medieval agriculture as has been done in economic histories and histories of agriculture, does not properly reflect the contemporary social reality.

Primary Sources

There are seven manuscripts in the collection of the Asiatic Society of Bengal, Calcutta (ASB). Of these *Risala Nakhlbandiya* is extant in the collection of Jamia Hamdard, New Delhi (JH), and *Risala Irshad az-Zaraat* is available in its complete form in the collection of Jamia Millia Islamia, New Delhi (JMI). Besides, *Risala dar Falahat* of the ASB is the same as the one in the collection of India Office (IO), London, where it reached after the transfer of East India Company library to the Crown. Center of Advanced Study in History (CASH) of Aligarh Muslim University (AMU) has a rotograph of it. Thus, besides the ASB collection mentioned above, there are three manuscripts on horticulture in JMI; one in Maulana Azad Library (MAL) of AMU; one in National Archives of India (NAI), New Delhi. Even then the total count of manuscripts on horticulture in various collections of India and abroad is very limited.

On comparing the content of various manuscripts one notices overwhelming overlap regarding the aspects handled and the way the various plants are described. Some times even the sequence in which plants are discussed is also identical in a number of sources. Interestingly, even some calligraphic mistakes are common. The reason for such overlap becomes obvious if we look into the acknowledged sources of information by different manuscripts. Leaving aside those that are not explicit about their source(s), acknowledgement of sources in various manuscripts is as follows:

1. Anonymous, undated, *Risala dar Falahat* (IO-479, and CASH, AMU-193) acknowledges as its source for information.

2. Anonymous, 1207 AH/ 1792 AD, *Kitab-I-Falahat,* (MAL, AMU, *Farsia Ulum-51),* mentions *Kitab Shajrat-an-Nihal* and *Ganj Badaward* as its source for information.

3. Ahmed Ali bin Mohammad Khalil Jaunpuri, 1205 AH / 1790 AD. *Risala Nakhlbandiya* (JH-862) acknowledges *Kitab Shajrat-an-Nilzal* and *Ganj Badaward,* as its source for information.

4. Anonymous, undated, *Kitab Irshad az-Zaraat* (JMI-672) though does not mention any source, its overlap with the CASH-AMU rotograph of the IO manuscript helps us to conclude that *Kitab Shajrat-an-Nihal* is its source.

Thus, *Risala Nakhlbandiya, Risala Shajratan-Nihal* and *Ganj Badaward* emerge as the three major sources for all horticultural information in the various manuscripts. However, *Risala Nakhlbandiya* mentions *Kitab Shajratan-Nihal* and *Ganj Badaward* as *"min musannifat Amanulla Husaini"* (among the compositions of Amanulla Husaini). No other source mentions the author of the *Shajrat.* Interestingly, *Ganj Badaward* itself mentions the *Shajrat* as a source but without naming the author while authors of all other sources are named. This situation seems to imply that Amanullah Husaini himself was the author of the *Shajrat*[8]. Hence, with such indirect support, we have to take this statement of *Nakhlbandiya* seriously into account. In other words, being composition of the same author, the *Shajrat* could be a collection of horticultural information that was later added to the *Ganj* to make it encyclopedic. *Ganj Badaward* is primarily a source of *Unani* medicine. Hence, those working with horticulture did not at all consult it. As we see, what emerges from the details given above is the fact that all information comes from one single source i.e. *Ganj Badaward* that is dated to 1035 AH/ 1625 AD[9].

Ganj Badaward is a treatise of *Unani* medicine. Following an old tradition the author has also included a number of *Amal* or Sections that deal with areas having a direct or indirect bearing on medicine. Out of more than fifteen such sections, *Amal Yazdahum* or the Eleventh Section deals with horticulture. The IO manuscript in fact begins as *"Amal Yazdahum dar Falahat"* (Section Eleven, Regarding Horticulture) and continues with methods for the identification of good / bad soil and ways to improve the soil exactly as given in the *Ganj.* We may note that the mention of Section Eleven in the IO manuscript makes no sense as there is no other section in it. Obviously, the copier copied the text *verbatim* from the *Ganj*.

In spite of some variations, the various compilations from this one single source when looked at as a whole do faithfully present the horticultural content of

the *Ganj.* The infonnation content of this source predominantly deals with a whole range of more than two hundred plants individually discussed and concentrates on how best to cultivate them. In this context grafting techniques for the production of new varieties of fruit plants and their improvement as well as plant protection and fruit preservation in storage occupies an important place. However, before dealing with these aspect we would like to have an overview of the floral content of medieval Indian orchards for which information, though scanty, is never the less available for both the Sultanate period and the Mughal Empire.

Floral Content Of Medieval Orchards

The *Sirat-I-Firuzshahi,* a manuscript dated 772 AH/ 1370-71 AD, gives some details regarding the plants that came up in the orchards of Hisar-Firuza. The long list makes very interesting reading as, besides the known tropical and subtropical plants like betel-nut *(Areca catechu),* banana *(Musa sapientum),* fig *(Ficus carica),* tar *(Borassus flabellifer),* āmlā *(Emblica officinalis),* orange *(Citrus sinensis),* date-palm (*Phoenix silvestris),* mango *(Mangifera indica)* etc, it also mentions *perennial* temperate fruits like aru *(Prunus puddum),* amrud *(Pyrus serotina),* pomegranate *(Punica granatum),* grape *(Vitis vinifera),* plum *(Prunus* sp.), apricot *(Prunus armeniaca),* apple *(Malus pumila),* peach *(Pyrus communis),* pear *(Prunus nivalis),* walt-nut *(Juglans regia),* pistachio *(Pistacia vera),* almond *(Amygdalus communis)* etc. as growing in these orchards. It also pointedly mentions *Zaitun* or olive *(Olea* sp.) cultivation there[10]. The same inclination towards a mixture of temperate and tropical plants is also visible in flowers, vegetables and other aromatic and medicinal plants. Though some plants like grape, plum, apricot, apple, pear and pistachio etc do not surprise the reader as these even today are found to be growing in the various localities of the Indian plains, plants like olive do create some consternation. In this context let us recall two points.

Firstly, let us for a better understanding separate the three aspects of a perennial tree that usually are seen as a well connected series to make a successful cycle: (a) growth, (b) flowering, and (c) bearing fruit. While, for example, cherries and apples easily grow and abundantly flower in the private lawns of Delhi today, their fruit aborts very prematurely due to high temperatures of early April. Coconut and betel nut palm, for example, may be seen

growing in Delhi here and there but they do not produce flowers or fruits. Flowering and fruiting of a plant are determined by its photoperiodic and temperature responses in the new setting. Hence, if these plants are cultivated in Hisar-Firuza, the reason behind such cultivation cannot be the use of their fruit alone. Some may have been cultivated for decorative purposes or simply as a collection of diversity as in a botanical garden today. Others, as we shall see shortly, may have been cultivated for grafting purposes. Olive illustrates the second aspect. Under the impact of the theory of the Centers of Origin of Cultivated Plants olive is popularly considered to be a plant of the Mediterranean Center of Origin[11] as there it grows wild and has been cultivated for millennia over very large area. This fact regarding one of the species of olive viz. *Olea europeae* is projected to all species of the genus. However, the facts regarding olive in scientific literature are very different.

From the point of view of plant geography the genus *Olea,* to which all olives belong, is spread wide over a range starting from the Mediterranean coast and southern Europe to northwestern Himalayas[12]. From the point of view of plant taxonomy there are thirty-six species in the *Oleaceae* family out of which eight species of the genus *Olea* are met with in the Himalayas[13]. *Olea dioica* is found wildly growing in Darjeeling; *O. feruginea* and *O. glandulifera* are found wildly growing from Kashmir to Kumaun. Of these *O. ferugenea* is specifically designated as the "Indian Olive"[14]. In other words, these eight species of olive may be considered as being native to India. From the point of view of phyto-chemistry heavy portion of the crude oils used in industry is the same in *O. europeae* and in the *Olea* species found wild in India; edible oil produced by Indian species of *Olea* though much less in quantity, is the same in its chemical quality[15]. In other, words, mention of the cultivation of olive in Hisar-Firuza should not be a surprise from the point of view of phytochemistry and plant-geography. In this context we may also recall two more points. Firstly, there is no evidence either in indigenous medicine or in the medieval revenue and other records to show that medieval India ever imported olive oil in any worthwhile quantity though it is, and then was, an important ingredient of *Unani* system of medicine and was also used in *Ayurveda.* It seems olive oil required for medieval medical purposes could easily be obtained from Indian olives too. Besides, we should not ignore the fact that British attempts at growing

O. europeae did succeed in the Howrah Botanical Garden though there it did not produce any fruit[16]. However, today it is being successfully and commercially cultivated in the Neelgiri hills [17]. In other words, even *O. europeae,* if it had been brought to medieval India through any channel, could have been successfully grown to its complete cycle in medieval orchards. Since in non-specialized parlance all the species of *Olea* are called olive, the comment of Blochmann regarding the weight of the olive wood mentioned in *Ain-I-Akbari* [18] obviously refers to two different species of olive, one European, to which Blochmann is referring to, and the other native to India that the *Ain* seems to be handling in terms of wood density.

Though textual account of the floral content of the Mughal orchards is scattered, the big painting of the layout and content of the garden at Taj Mahal, now located in the site museum, provides substantial details of the floral content and orchard layout. In this respect Mughal orchards seem to be no different from the Sultanate ones that also had fruit trees, aromatic and medicinal herbs, decorative flowers etc and were also laid out in the pattern of a *Cār Bāgh as* described in the central Asian horticultural manuscript of Bu Nasri in detail[19]. Leaving obvious uses aside, medieval orchards appear to be a very busy hub for production of new fruit varieties through various grafting techniques. We may also note that mention of temperate plants growing in the medieval orchards should not come as a surprise. These not only can grow under subtropical Indian conditions [20] but, when not fruiting, may be seen to be useful from the point of view of various combinations for grafting to improve the scion quality that we shall discuss shortly.

Not much has survived from the orchards of the Sultanate. The remains of a terraced garden could yet be traced in the Munirka sector of south Delhi [21]. Lodhi Garden seems to be a highly Anglicized version of what once must have been a Sultanate garden with a water channel flowing through. Humayun's Tomb seems to even today show the basic elements of a *Cār Bāgh* that occupied an important place in central Asian tradition.

Bu Nasri mentions more than thirty-five varieties of apricots; he also records twenty-five varieties of grapes[22] which underline the fact that these central Asian orchards were a major center of horticultural experimentation for

which end grafting methods were frequently used. For this purpose a number of techniques were employed and when a variety was successfully produced, these were vegetatively multiplied and propagated as true to type. Such information being available in India, certain plants would then be cultivated not so much for their fruit but also for their role in grafting for fruit improvement. Progress of the art and science of grafting played a very significant role in this context.

Grafting Techniques In Indian And Central Asian Horticul Tural Manuscripts

Ganj Badaward is the earliest primary Persian language *Indian* source on horticultural techniques that has survived to this day. We should also note that the grafting techniques mentioned in it though appear simple require a high level of expertise not only for using the various techniques, but also for selecting the pairs to be so joined together. This combination seems to be more important as the techniques remain constant over a wide range of combinations.

In the above context we may note that a certain opinion prevails among the historians of agriculture that the invading Truce-Afghans and Mughals brought the art and science of grafting to India. To us this aspect yet needs special investigation cutting across the existing watertight linguistic divide between the ancient and the medieval phases of Indian cultural continuum. At this juncture we may only mention that a comparison of *Ganj Badaward* (1625 AD) and *Irshad az-Zaraat* (1515 AD) in spite of considerable commonality in techniques does not warrant the conclusion that the former is only a compilation from the later or some other central Asian source. This point is illustrated by the fact that Amanulla Husaini illustrates the methods through both temperate and tropical examples while Bu Nasri remains exclusively confined to temperate plants alone. In other words, Husaini goes much beyond Bu Nasri under conditions that are alien for central Asia.

One of the grafting technique recommended for all "rough and thick-skinned plants" like fig etc. consists in drilling a hole in the branch of the mentor. There are two very interesting moments in the discussion regarding this technique. Firstly, the method requires a hole to be drilled into the mentor

branch that should be of the exact size of the scion and such drilling should "injure the real wood" *(ta chob-i-asli ra zarar barasad).* It is interesting to note that *Nakhlbandiya* insists that this hole be made by "a nail from the wood of *Gaz* (Tamarisk-tree) or any other hard wood" (*maikhi az chab-i-gaz ya chob-i-digar ke mohkam barasad*) [23]. Such avoidance of metal when metal in agriculture was in increasing use appears to be interesting. We may note that another manuscript from central Asia also mentions such techniques, but after mentioning wooden drill informs that "these are old methods. There are now newer techniques that are simpler. These are well known [24]. While the manuscript of Bu Nasri is internally dated to 921 AH/1515 AD, the later central Asian manuscript is anonymous and undated. However, a verbatim copy of it is extent in the National Archives of India. This copy is dated 1771 AD[25]. Such usage of central Asian information indicates that even till the late eighteenth century such technical information from central Asia was considered to be of interest for the further development of Indian horticulture. Another variation of this drilling technique consists in the hole going through the entire thickness of the mentor branch to open on the other side. The scion branch is inserted in this hole in such a manner that the portion with a number of buds comes out on the other side [26]. The joint on both sides, but without cutting the branch, is then covered with mud and cow-dung mixed with clean soil *(gil-i-pakiza),* and kept moist by water dripping over it all the time till the buds on the scion branch start growing. The scion branch is then cut off so that it starts taking its nutrition totally from the mentor.

The other point of interest concerns an expression that is of high significance for inferring the wood anatomical understanding of the times. While discussing the drill, the text mentions that, *"ba asl chob-i-an zarar barasad"* (so that the real wood of it is hurt). It seems to be clear that for the given times, entire twig in its diameter was not wood; the "real wood" for them was surrounded by non-wooden tissue. Any damage to the "real wood" appears to stimulate tissue growth that would first press and then join the scion branch with the mentor and also stimulate bud growth in both. It seems that the "real wood" is not the secondary metaxylum but the meristematic cambium layer along with the pericycle. This point emerges from the fact that only *some injury* is to be caused to stimulate it; the drill need not penetrate deep into the middle

of the branch. The other alternate would be, that the nail goes up to the outer layers of secondary metaxylum; for doing this it would have to pass through the earlier layers including those of cambium and pericycle and cause them injury [27]. Since no direct evidence on the medieval Indian understanding of wood anatomy is available to date the only recourse that one can take is to analyze the expressions used and from these infer the knowledge implied.

After the discussion on technique, the *Ganj* discusses various combinations of mentor and scion for grafts. This discussion brings us face to face with another interesting aspect of medieval Indian understanding of mutual affinities and relationship between different plants.

If we altogether ignore the anthropomorphic expressions of love between various trees for each other, it becomes obvious that their understanding of mutual compatibility between plants went much beyond the taxonomic closeness that we notice in modern classification. Here are some combinations that are recommended for grafting. Peach *(Pyrus communis,* family: *Rosaceael Pomoideae)* on mulberry *(Morus nigra,* family: *Moraceae),* apple *(Pyrus malus,* family: *Rosaceae/ Pomoideae);* apricot *(Pygeum persica,* family: *Rosaceae / Prunoideae*) on almond *(Prunus amygdalus,* family: *Rosaceae / Prunoideae);* all the above on quince *(Cydonia oblonga,* family: *Rosaceae* I); orange *(Citrus aurantium,* family: *Rutaceae),* on apple, orange on mulberry; pomegranate *(Punica granatum,* family: *Punicaceae),* on orange; olive *(Olea* sp. family: *Oleaceae)* on grape *(Vitis vinifera,* family: *Vitaceae)*; grape on apple; fig (*Ficus carica,* family: *Urticaceae/Moraceae*) on mulberry; apple and peach, etc.[28] It is also pointed out that if orange is grafted on mulberry the color of it shall turn red. [29] In other words, various combinations are made to differently affect the color, size, smell and taste of the grafted fruit. We had noted earlier that a diversity of fruit plants was grown in medieval gardens. Even if, for example apple did not bear fruit, its role in grafting combinations would justify cultivating it in a medieval orchard. Similar situation prevails with a large number of other temperate fruit and nut bearing plants.

Another method of grafting that is especially recommended for grapes brings to fore yet other countenance of the medieval understanding of plant reaction to injury and the extent to which this injury may be tolerated by the plant. This method is recommended to produce a "horticultural wonder" in

which different varieties of grape are grown on the same plant. This technique has two variations. In the first method, about "half a *gaz* [30] of branch is first cut off at both ends and then vertically sliced into two or four parts and its pith *(khakaster)* is removed. The inside is then filled with ash, cow-dung and some lime mixed together, firmly tied, smeared with a mixture of cow-dung, ash and clean dust and tied with silken thread, again smeared with cow-dung and dust, wrapped in leaves and firmly tied. This bunch is then buried in the soil to about half a *gaz* and watered. The soil is kept moist by regular watering. The other variation of it is as follows. The mentor is hollowed by the entire removal of its pith. In this hollow some clean dust is smeared to remove the "watery drops" that appear inside. Then the above scion combination is inserted into it by about half its length, covered on the joint with a mixture of ash, clean soil and cow-dung, packed with clean soil, wrapped with leaves and tied with a silken thread.[31] It is to be kept moist all the time as described earlier. Yet another interesting moment in this description consists in the removal of the "watery drops". It is well known today that damage to the tissue results in the exudation of some products that in their turn cause further damage to the living cells with which these come into contact. Insistence on their removal by dust absorption seems to imply practical knowledge of this deleterious effect of injury exudation.

There is yet another interesting method that is mentioned in the context of date palm *(Phoenix sylvestris),* a monocot. In this method "skin" of the scion is firmly placed on the mentor from where similar portion has been removed. This method could well be reciprocal. It is stated that by this method the quality of fruit in the mentor improves[32].

In case of pomegranate a branch of fruit bearing plant is "broken by hand", the "skin" of its margins trimmed, and then it is joined to the one that does not bear fruit at a place suitably prepared earlier. The whole is then smeared with a mixture of soil, cow-dung, ashes and manure and tied with silken thread[33]. We may note that by tearing the branch one removes the tissue sequence intact but in a damaged state. Over time this damage-stimulated fibrous tissue grows and joins with the mentor.

In the above discussion of different methods we feel that by implication the author recognizes the anatomical difference between the date palm, a pe-

rennial monocot, and others that are dicot perennials. He also seems to underline that dicot methods may not yield result in case of the monocots due to absence of secondary growth.

The *Nakhlbandiya* mentions a simple method of mango (*Mangifera indica*) grafting that according to it was then common in the environs of Murshidabad in Bengal. In this method the scion branch of about 18-20 centimeters[34] (*baqadr yak wajab*) is cleaned of its skin and adjoining tissue so that its "real wood" is exposed and stimulated. Then the exposed part is put in contact with the exposed portion of the mentor also treated in the same manner, tied with a thread and covered with a mixture of mud, ash, cow-dung and manure. On it the *Dabh* grass is wrapped and the whole is covered with clean soil and dung and is smeared so that its juices do not come out. It is kept moist by drip of water. When after two weeks the roots appear, the mentor branch to which scion was attached is cut bellow the rooting portion and put in the soil [35]. One may observe this method in practice even today in the mango orchards of Malihabad and its environs. This method seems to be a variation of the simplest grafting method that is described in two variations. It consists in growing the mentor and the scion very close to each other. When the plants are of about two years old and are long and strong enough, these are firmly tied together so that during further growth they fuse. After fusion has taken place, the scion is separated from its roots while the mentor is cut to remove all of it above the joint[36]. The variation of this method consists in the following. Before binding together the skin and the portion underlying it is removed from corresponding portions of both the branches that would ultimately get fused. The two are then brought into contact and firmly tied together. In due course the cut portions under the impact of injury stimulation start to grow and, being under pressure, fuse[37].

It is interesting to note that Bu Nasri recalls all the above methods. However, the anonymous and undated central Asian manuscript (JMI-673) mentions two techniques that are not recalled by Bu Nasri. One of these, the cleft method *(ba tariq-i-shaq)* is not at all recalled in the Indian sources. However, the other, the gate method *(ba tariq-i-naqab)*[38] is implied in the situation discussed earlier for pomegranate. In case of pomegranate the hand broken branch is trimmed to shape and then joined to a point where corresponding area has also been cleared of the "skin.

In the cleft method the mentor is cut in the form of V and its pith is removed. The cut surface is then smeared with clean soil to dry it. The scion is suitably cut to fit into the V but its pith is not removed. Its cut surface is also made dry by a smear of the type mentioned earlier. The two are fitted together and tied with a thread. The whole is then smeared with a mixture of cow-dung and ashes and kept moist by water drip till the graft has taken [39].

Season and Time for Grafting in the Indian Sources

All the sources consider the season and time of the day for planting and grafting to be very important. For example *Nakhlbandiya* informs that the best span of time for grafting is from the beginning of Libra till the end of the Pieces and the start of Aries. It recommends the season of fall as best for grafting and also informs that plants that are grafted or otherwise put in the soil during spring do not grow fast or produce abundantly. It is also underlined that planting of both cuttings and grafts should be done when the moon should either be waning or be behind the earth as the planting during the increasing light of the moon results in their growing high and give reduced yield [40]. These points are common to all manuscripts, be these of Indian or of central Asian origin. All the sources also mention that grafting should be avoided at a time when northern cold wind was blowing; grafting is more successful when done during the proper season with warm temperatures and when the day and night are of equal length[41].

Plant Protection Under Field Conditions

Both Indian and central Asian manuscripts are emphatic on the profit aspect of horticulture. From this point of view keeping the trees healthy and preserving the fruit fresh for a longer span of time acquires added significance. Hence separate sections dealing with this aspect in central Asian sources while the same is provided summarily and in some individual cases in the Indian sources. The methods of plant and fruit protection given in both the cases are entirely organic. For example it is mentioned that if for this end beans and gourd trees are grown adjacent to the apple tree, worms in the soil or insects of the air shall not attack the apple tree[42]. The same method is recommended for protecting grapes from the insects[43]. It is of interest to note that repeatedly wild onion *(Urginea scilla)* is recalled as an agent that protects the underground

parts from soil borne worms, presumably nematodes. For this purpose the long leaves of it are cut into pieces and buried near the roots. Such presence even after decomposition of the buried parts continues to repel the worms of the soil[44]. This method is also recommended for apple, pear and pomegranate[45]. The same property is also attributed to the bile of a he-ass or that of a cow [46] and to the faeces of man[47] and to burnt borax that is given in watery solution [48]. It is also mentioned that olive leaves if wrapped on the branches of a fig tree, or smearing of its juice on the branches gives the same effect [49]. This practice is recommended for trees with good fiber and thick and rough skin. It is also mentioned that if the branches of an old pomegranate are covered with gourd leaves it remains protected from the low winter temperatures[50].

Protection Under Storage

It is interesting to note that the Indian manuscripts do not pay serious attention to this aspect though scattered mention is made to such practices. In this context it is interesting to recall the well-known observation of Ibn Battuta that during a famine stored grain was taken out. This grain was in storage for nine decades. Though its color had turned black, this change has not affected either its taste or nutritional value. Though Ibn Battuta is silent about the method of conservation, from the text we may suspect that such storage was without the grain being packed in mud in a container as Bu Nasri tells us. Bu Nasri states that by such methods grain could be stored for six decades without damage [51]. Such examples seem to underline that during the medieval times a number of methods were available to both central Asia and India for substantially long preservation of grain and were used according to the concrete conditions to get best results.

Above discussion makes it abundantly clear that plants grown in a medieval orchard had multiple usage. Unlike the exclusive monitory benefit focus of present day horticultural cultivation, various other non-monitory considerations seem to have dictated the decision regarding which plants to grow. Besides, the point regarding diverse usage of plants clearly emerges from the mention of such instances as the flower of gourd, the juice of lemon or of mango leaves, extract of turmeric, skin of orange, leaves *hina (Lawsonia alba),* juice of grape, etc that were very much in demand for use in various processes of dying [52] were cultivated for such purposes. Such multiple and diverse usage

of plants in the medieval society should never be lost sight of while dealing with medieval horticulture and content of the medieval orchards as these orchards in essence served the medieval society in its complex requirements. This society was entirely and exclusively dependent upon plants for the satisfaction of all their needs.

Honeybee and Silkworm Rearing in the Orchards

Bu Nasri discusses honeybee rearing in substantial details. If we ignore all expressions that reflect anthropomorphic societal attitudes, the information regarding the lifecycle and the role honeybee plays in enhancing the rate of fruit and seed formation is substantially correct. The various characteristics of different forms of honeybees in a comb are also precise and correct. Bu Nasri pays special attention to the problem of saving the hives from intense cold in winter[53]. It seems there was no substantial difference between the wild and the domesticated honeybees in central Asia as catching the egg-laying "king" in the wild is recommended as the starting point of a new hive. It is also advocated that a hollowed hard-shelled gourd should be used to house the hive. Honey is collected from these hives by removing the bees by smoke or transferring the egg-laying "king" to a similar new gourd. Indian sources in this respect are entirely silent. However, Hakeem-ul-Mulk Nizamuddin Ahmed Gilani (1036 AH / 1626 AD) in his collection of treatise titled *Shajra-I-Danish* has a treatise on honeybee that in spite of its anthropomorphic and societal imagery provides substantially correct information[54]. Obviously, the information regarding the honeybee was available though it may not have been that important for the Indian horticulturists as it was for the central Asians who were using honey as a preservative for harvested fruits[55]. It is interesting to note that Hakeem-ul-Mulk Gilani has also composed a treatise on silkworm rearing while central Asian sources are totally silent on this count. Gilani informs that silk of various colours was obtained from different lines[56]. It seems such expertise has been lost by now.

For Whom Were The Texts Compiled?

In view of the fact that those working in the field were illiterate and transfer of information was predominantly oral, the question obviously arises as to who benefitted from these texts? Bu Nasri makes it clear that he com-

posed his text for those serving in the department of *Dahqaniyat* so that they may make efforts to increase the revenue of the king through improved horticultural methods[57]. *Dahqan* being the chief of the village, was literate and could orally communicate to those in fact working on the ground. Indian sources are entirely silent on this count. It seems reasonable to assume that Indian compilations or compositions were also meant not for the illiterate horticulturists working at the grassroots but for those among the literate officers of the court who were looking after the orchards of the nobles or of the king.

Conclusions

1. Medieval Indian orchards cultivated various types of plants with diverse ends in mind. Obtaining fruit was not the only purpose for growing plants in the orchards.

2. All known Indian primary sources have collected their information directly or indirectly from one source titled *Ganj Badaward* (1035 AH / 1625 AD) of Hakeem Amanullah Khan, son of Mahabat Khan, also known as Khanzad Khan and Firuzjang. He was court physician of both Jahangir and Shahjahan. Since this work is essentially of *Unani* medicine, so far no attention has been paid to it as the primary source of horticultural information in the Indian sources.

3. It is characteristic of medieval Indian orchards that perennial temperate fruit plants grew in them along side with tropical ones while in central Asian orchards due to prolonged sub-zero temperatures and snow-covered winter only temperate perennials could be grown. This distinction regarding the cultivation of perennial tropical plants may be taken as floral criteria to distinguish central Asian manuscripts from Indian sources as both are in Persian and use the conventional Arabic and Persian plant names.

4. As there are species of Olive that are native to Indian Himalayas and even *Olea europeae* is being commercially cultivated in the Neelgiri Hills, there should be no surprise in finding olive being cultivated in the medieval Indian orchard.

5. Details regarding grafting techniques permit the inference that the medieval horticulturists knew about the role different anatomical layers of stem played in branching and healing processes.

6. It is obvious that the medieval horticulturists knew the differences in the anatomy of monocot and dicot stem.

7. A number of grafting techniques from most simple to quite complex coexisted. Depending upon the plant response, different techniques were used.

8. Medieval horticulture paid special attention not only to temperature conditions prevailing at the time of grafting but also took the position of the moon and its various phases into consideration for determining the time of grafting that in its turn influenced the yield.

9. Different plant and animal products were used to protect the growing plants from insects and worms. Similarly such products were used to protect fruits, vegetables and grain in storage over long periods of time.

12. Burnt borax solution in water and salt are the only chemicals mentioned in the sources.

13. Medieval horticultural sources ofIndian origin are totally free of all religious citations while central Asian manuscripts pay special attention to the emphasis laid on horticulture in Islamic teachings and the sayings of the prophet.

14. Central Asian sources mention honeybee rearing though these are silent on account of silkworm. On the other hand Indian horticultural texts do not mention honeybee but refers to silkworm. Substantial information about honeybee and silkworm is provided by some of the *Unani* medical authorities.

Acknowledgement

The contents of this paper are based on the material collected for the completion of the INSA project, titled "Critical edition of a Persian manuscript *Risala Dar Falahat* with English translation and notes" for which I am thankful to INSA.

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